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**Testimony before the
Senate Subcommittee on Science, Technology, and Space
of the Senate Committee on Commerce, Science, and Transportation**

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My name is Judith Rodin. I am president of the University of Pennsylvania, and a member of President Clinton's Committee of Advisors on Science and Technology. I am also a biobehavioral scientist and an educator.

It is a privilege to appear before you this afternoon. I would especially like to thank Senator Frist for inviting me to share my views on the place and importance of university-based research to our nation particularly at this critical moment in our history. It is also a privilege because it gives me an opportunity to express publicly my gratitude for the generous support my research and scholarship have enjoyed over the years from both the National Institutes of Health and the National Science Foundation. My career as a biological psychologist and a professor has depended upon such support. I am keenly and personally aware of the key role the federal government plays in investing in people and advancing science. Finally, it is a privilege to testify before this Subcommittee, chaired as it is by a physician and clinical investigator, someone who has also dedicated his life to research, service, and improving the quality of life of our fellow citizens. I know that Senator Frist and the other Senators on the Subcommittee understand the interdisciplinary nature of science, and the contributions that engineering and materials science have made to the art and craft of sophisticated surgery.

I believe that the subject you have invited me to discuss -- university research -- is critical to the nation's future. And I will try to tell you why.

As I mentioned, I am president of the University of Pennsylvania. We were founded by Benjamin Franklin in 1740. We are a university dedicated then, as we are today, to the pursuit of knowledge and teaching that spans the continuum from the fundamental to the applied, from theory to practice, from theoretical physics to healthcare delivery. Ours is the mission of the research university: to pursue knowledge, to teach, and to serve the public. We do not take that mission lightly or for granted. It is largely the partnership between the federal government and universities, which has made and makes this enormously successful enterprise possible -- a system that is the envy of the world.

The University of Pennsylvania is the largest research university in the middle Atlantic region and one of the ten largest in the country, based on the level of federal funding for research. Our annual academic expenditures are around one billion dollars. Of that, \$300 million -- or about thirty percent -- is federally-sponsored research. Three-quarters comes from the Department of Health and Human Services, mostly from the National Institutes of Health; 7 percent from the National Science Foundation; 5 percent from the Department of Defense; 7 percent from the Department of Education, and the remainder from the Department of Energy and other agencies.

The total budget for externally-sponsored research awards at Penn is \$365 million. Of that only 6 percent comes from industry. Many American industries have been reducing their commitments to R&D under the intense pressure of maximizing short-term profits. They have also, for the same reason, not been investing as much as we (and they) would wish in university-based research.

Research is a major part of what Penn does. If I may, I would like to introduce for the record, fifteen examples of on-going, federally-funded research projects at Penn. We, and their peer-reviewed funders, believe that these projects have the potential to transform the quality of our lives. Some may not. Surely some will. They range from developing digital radiology that will improve medical

diagnoses, to creating new "designer" enzymes to fight cancer, to studying ways in which we can enhance the long-term viability of the fishing industry.

But our research is not only designed to answer fundamental questions in science, engineering, and medicine. It is also an integral part of what the university is about. We teach students: undergraduate, graduate, and postdoctoral. All participate in our research, and all benefit from being in an environment where research takes place. This synergy is the source of the educational opportunities provided by the American research university. We teach our students not just skills or facts, but also the methods and standards by which they may, after they graduate, evaluate, discover, and sometimes create new knowledge. Research, teaching, and service in the modern research university reinforce each other making our sum much larger than our parts.

It was not by chance that this country has developed the world's best university system and the world's leading research enterprise in the last 50 years. It required vision, the commitment of funds, a willingness to support merit-based, peer-reviewed research, and, most important, a sustained confidence to invest in the future. The post World War II generation rightly assumed that today's investments will yield tomorrow's returns in better healthcare, in a more vibrant economy, and in enhanced national security. Their faith laid the foundations for both the modern research university as well as our current prosperity, not to mention our pre-eminence in world affairs.

The modern research university came of age after World War II when the federal government decided that sustained investments in science would improve the lives of citizens, while also helping make us more secure in a tumultuous world. It also decided the best place to do the research was in the laboratories of the nation's universities.

Why? Because university-based researchers were not only positioned to discover new

knowledge, they were also able, as I noted a moment ago, to educate the next generation of scientists, engineers, and doctors. These students, upon graduating, would take the fruits of the new knowledge into the workplace, to the bedside, and onto the battlefield. And, it should not be forgotten, this system provided the least expensive way to harness the power of science because the universities provided the people and the infrastructure.

Much has changed since this paradigm was put in place. Most notably the Cold War no longer exists, and some argue that we need new impetus for research in the future.

I concur. We do. We need better national policy that will foster new forms of organization and support for academic research. We need to better reward entrepreneurial behavior and imaginative restructuring both at the federal and university levels that takes advantage of new cross-disciplinary discoveries that have come so rapidly in recent years. And we need to be even more productive.

But we should not forget how we got to this propitious moment. This nation's successes in healthcare, industry, and national security were based on a sustained commitment to research and to building the human and physical capacities to carry it out. Our innovation and our great economic success is due, in large measure, to the research enterprise in which this nation wisely invests.

Before I address some of my concerns -- namely the declining federal investment in science outside of the biomedical area -- both in real dollars and as a share of GDP, allow me to briefly review with you some examples of research that have transformed America and the world. Now more than ever, because the foundation of our new economy is so dependent on new knowledge and innovation, we must not forget the sources of our success in the past. I believe those sources will be even more important in the future.

First, take the computer, the machine that created the information age. Where did it come from?

Answer: the University of Pennsylvania. ENIAC, the world's first large-scale, general purpose digital computer, was, with the help of federal funding, unveiled in a laboratory at Penn in 1946.

Second, the biotechnology industry. Where did it come from?

Answer: the discovery of recombinant DNA techniques developed in the 1970s at Stanford University and at the University of California San Francisco.

Third, the Internet. Where did it come from?

Answer: based on four decades of research, most of which was funded by the Department of Defense, scientists at the NSF's supercomputer center at the University of Illinois in the 1980s perfected the browser and unleashed the latest communication revolution.

Intuitively, we understand the transformative power of science in the national interest. The data support our intuitions. My former colleague at the University of Pennsylvania, the late Edwin Mansfield, found that the private rate of return to a company investing in R&D is about 25 percent a year on average, while the return to society as a whole averages 56 percent a year!

I doubt that the Congress could find a higher rate of return on any of its investments in the future.

Let me also share with you the results of the sixth annual licensing survey just released by the Association of University Technology Managers. They found that in 1996 estimated sales of products developed from inventions made in the course of academic research and licensed to industry amounted to \$20.6 billion, and included 248 new start-up companies that year alone.

Innovation, we know, is going to keep America strong. And innovation, we also know, starts in

laboratories.

So why am I concerned, both for the universities and the nation, since it is so demonstrably clear that the system we have in place works, and works well.

I am concerned because slowly, but just as surely, we are taking more out of the system than we are putting back in.

As we discussed at the Council on Competitiveness Summit, held last month at MIT in Cambridge:

- In 1995, the Federal government provided an estimated \$61 billion in R&D funds, or 36 percent of the national total.
- But between 1987 and 1995, Federal R&D fell an average annual constant dollar rate of 2.6 percent.
- The Federal share of the national R&D total has fallen in those years from 46 percent to 36 percent, and would be much worse were it not for the healthy, recent increases in NIH funding.

This trend in federal funding has occurred while, as I noted earlier, industry support for basic research continues to fall, dropping 12.2 percent from 1993 to 1995. Meanwhile, the Japanese government has announced plans to double its R&D spending by the year 2000, and the European Union will spend more than twice as much per capita on non-defense R&D than we do by the year 2002.

Finally, a third data point, and, in many ways, the most impressive because it illustrates the importance of university-based research in the nation's economic performance. According to a new NSF

study, released March 17th, three-quarters of all patent applications in the United States cited publicly-funded research for at least one of the sources for their new discoveries or inventions. Even at IBM, a leading source of industry-based R&D, only 21 percent of its patent applications were based on company research.

I only exaggerate slightly when I say that, based upon these findings, were universities to stop doing research, in a little over a decade, we could expect U.S. industry to close up shop as well -- at least those frontline, innovative industries that maintain our position in the world economy.

It is in this context that the President's budget proposal for Fiscal Year 1999 was so welcome, calling, as it does, for historic increases for NIH and NSF in particular. We are also enormously encouraged that so many Senators have also been calling for increases in funding for the federal mission agencies, even before the Administration launched its new initiative. And, it is important to remember that the proposed increases represent a relatively small investment, especially in the context of a \$1.7 trillion budget. The proposed increases alone for this research add up to less than \$3 billion, and we know what kind of return we are likely to get on that investment, especially -- and this is the key point -- if it is sustained and invested wisely.

Which brings me to my final point. What principles ought to govern any increases in funding for science and engineering research? I would like to suggest seven, which I and my colleagues in the Association of American Universities have recently adopted.

1. The central focus of expanded funding should be research programs that are grounded in rigorous peer review of investigator-initiated proposals.

2. High-quality education of graduate students should be recognized as an inseparable component of research conducted in the academic setting.

3. Funding increases should be allocated across a broad front of scientific opportunity in recognition of the increasing interdependence of research across disciplines. [We must not forget the interconnectedness of science, especially the important links between the biomedical area and the physical sciences and engineering.]

4. As support for research is expanded, funding increases should be structured to assure stability and sustainability over the long term.

5. Expanded investment should include science and engineering infrastructure needs, such as facility renovation and modernization, instrumentation, information and computer technology, and animal care support.

6. Federal research policies should support full recovery of institutions' appropriately incurred costs of federally supported research conducted on their campuses.

7. Universities should assume responsibility for wide dissemination of the results of federally supported research and encourage the use of new knowledge for public benefit.

Mr. Chairman, again, I want to thank you for this opportunity to testify today. Like you, I have dedicated my life to science and service. It has always been a source of great pride for me to participate in the best research system in the world, one which produces scientific breakthroughs almost daily, not to mention Nobel Prizes annually. I have always felt that our strength as a nation depends upon our unflagging determination to discover new frontiers -- whether they be on Mars or in a single strand of DNA.

I know too that the strength of the system that permits us to do these things depends upon our collective ability to invest in it, to nurture it, and to manage it wisely so that it will continue to facilitate

American leadership in the world.